

# NAVY SEABORNE MATERIALS OPPORTUNITIES FOR STRUCTURAL AMORPHOUS METALS (SAMs)



**Structural Amorphous Metals (SAM) Pre-Proposal Conference**

*June 6, 2000, Arlington, VA*

**Dr. William T. Messick**  
**Naval Surface Warfare Center**  
**Carderock Division Code 0115**  
**301-227-4811**  
**MessickWT@nswccd.navy.mil**

# Outline

- **SAM Material Properties for Compelling Advances**
- **Navy Ship Environment**
- **Future Application Opportunities**
- **Summary**

# SAM Material Properties For Compelling Advances

- **Ferrous Alloys with High Corrosion Resistance**
  - Estimated Cost of Corrosion to Navy is \$ 2 B annually
  - Numerous Bulk Material Replacements or Coatings
- **Ship & Submarine Hull Materials**
  - 100 % Increase in Yield Strength of Today's Hull Materials w/ 100 % Increase in Dynamic Fracture Toughness
  - 50 % Increase in Modulus of Elasticity
  - Nonferromagnetic Behavior
  - No Crevice Corrosion for Life of Ship
  - 100 % Increase in Stress Corrosion Resistance at Strength Level
  - 50 % Reduction in Cost of Today's Superaustenitic Stainless Steels

# Navy Ship Platforms Environment



- Seawater - Fully Submerged and Air/sea Interfaces
- Threats:
  - Underwater Explosions (UNDEX)
  - Blast and Fragments

# Affordable Materials Solutions

**AFFORDABILITY Is Presently and Will Continue to Be a Major Consideration for Materials in Ships & Reduced Total Ownership Cost (TOC)**

- Low Fabricated Cost (Constituent Materials, Manufacturing, Fabrication/assembly)
- Low Development , Design and Validation Costs (Including Shorter Time Cycles)
- Low Maintenance Costs (Including Manpower Needs)
- Low Disposal Costs With Environmental Compliance

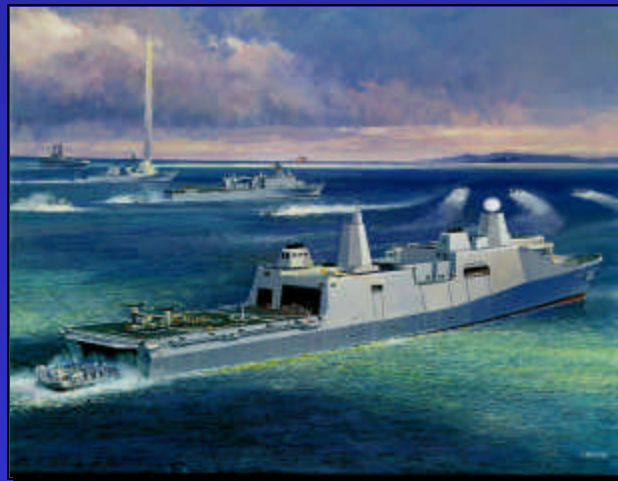


# Future Navy Operations In The Littoral

Reduced Surface Ship  
Multispectral Signatures

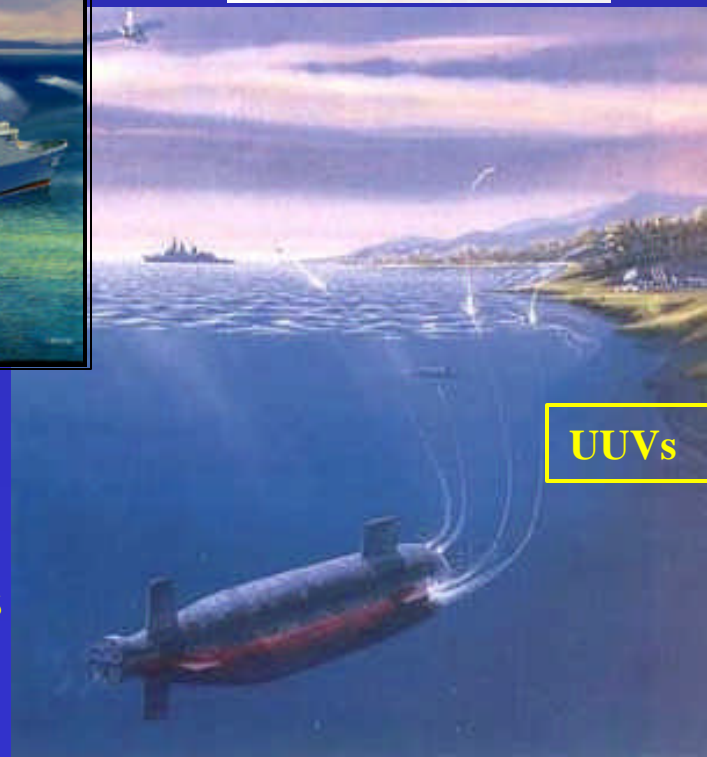
Marine Corps Assault Vehicles with  
Reduced Magnetic Signatures &  
Increased Protection Systems

Hardness Against Underwater Explosions  
(UNDEX), Air Blast and Fragments



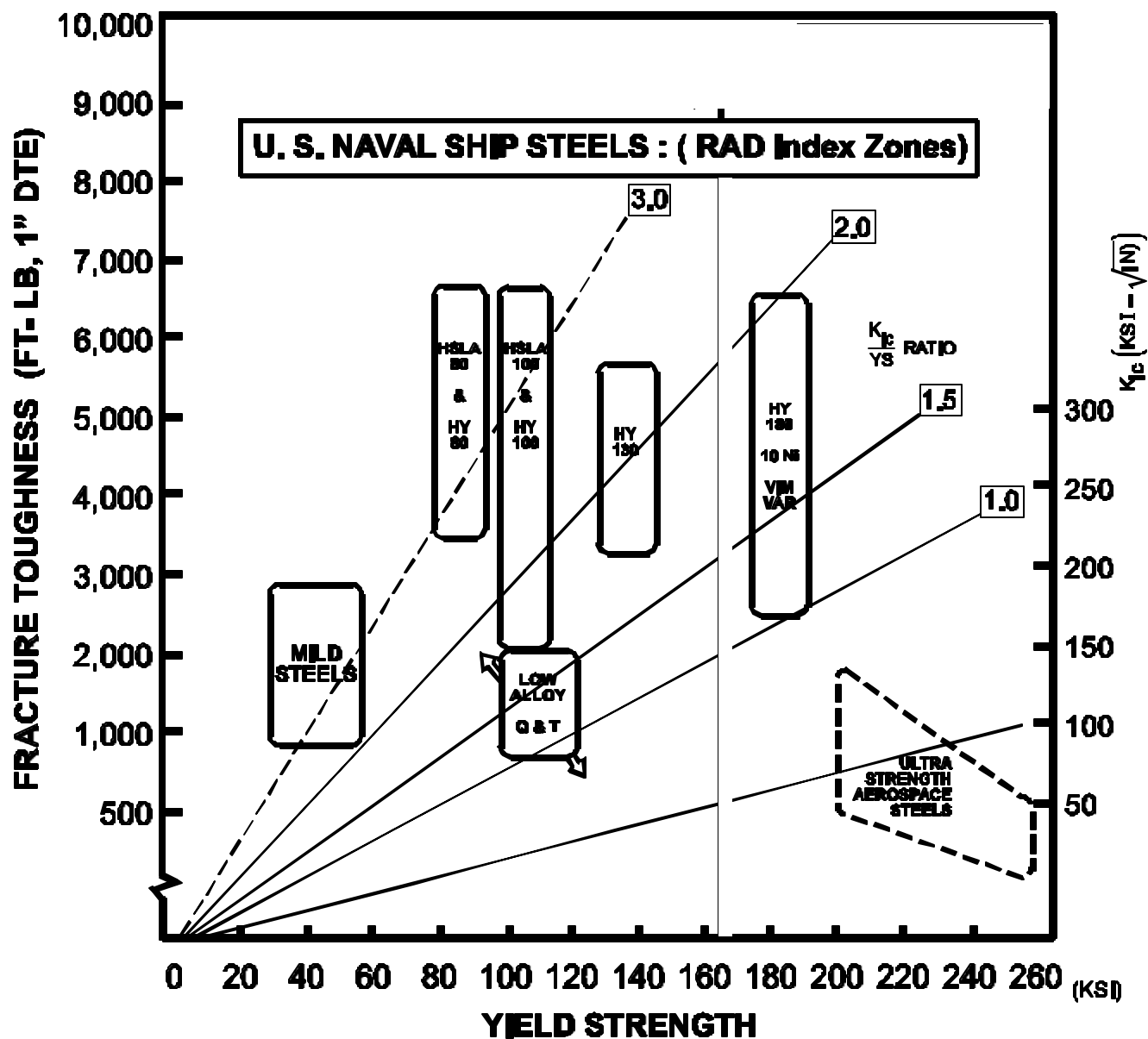
Reduced Submarine and UUV  
Magnetic and Acoustic Signatures

Higher Payload Fractions



UUVs

# Steels for Naval Construction



# Future Application Opportunities

- Nonmagnetic Double Hull Construction Concept For Navy Surface Combatant
- Nonmagnetic Submarine Hulls
- Protection Plating Systems (Magazines, Control Centers, Propulsion & Power Centers)
- Corrosion and Wear Resistant Coatings for Machinery Components
- Stiff, Lightweight Structural Panels (Foams, Lattices, etc.) to Reduce Weight, Particularly Topsides on Surface Combatants and Aircraft Carriers
- High Strength SCC Resistant Fasteners

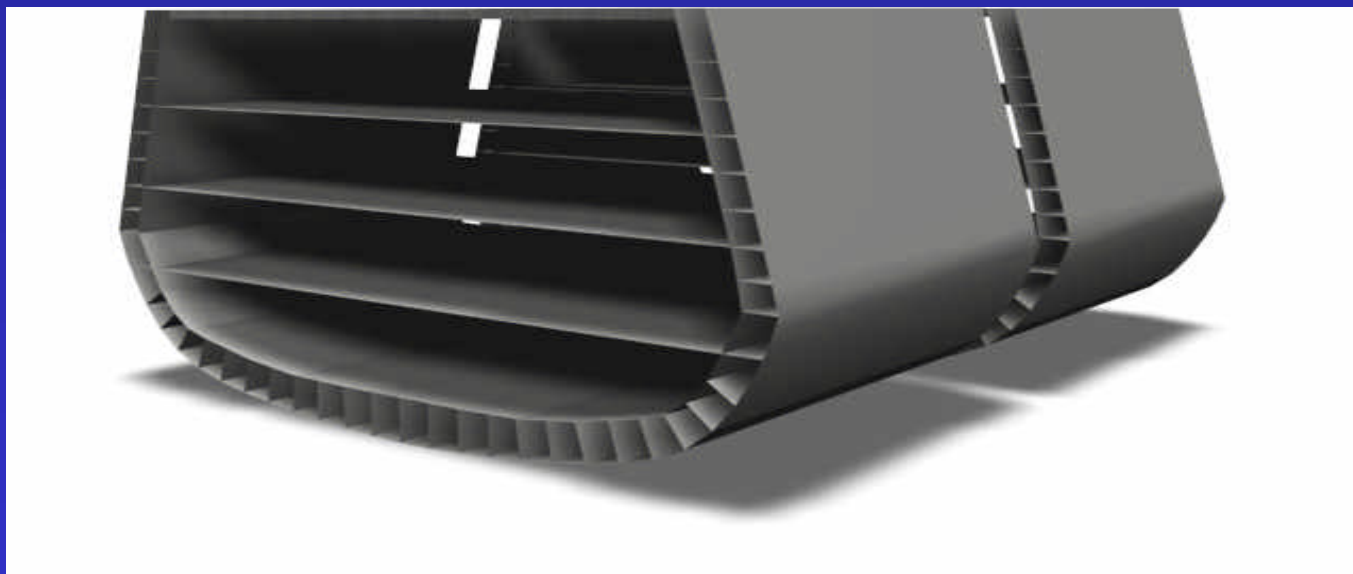


# Nonmagnetic Double Hull Construction Concept For Navy Surface Combatant

High Corrosion Resistance for Low TOC

Nonmagnetic Hull material  $\Rightarrow$   
Reduced Magnetic Signature

Inspection  
Techniques



Increased Damping for  
Acoustic Signature  
Reduction

Joining Technologies to  
Reduce Fumes and Distortions

Increased Strength and Toughness  
Nonmagnetic SAM Material  $\Rightarrow$   
Increased Resistance to Underwater  
Explosions

# Surface Ship Nonmagnetic Hull Materials

- Present Materials of Interest:

  - Superaustenitics AL6XN & Nitronic 50

  - Thicknesses up to 0.75 Inches

- Issues With Current Materials

  - Cost (\$ 3.00 - \$ 5.00 /LB)

  - Crevice Corrosion Resistance in Seawater/Marine Environment

  - Environmentally Acceptable Coatings

  - Low Strength Level (50 ksi Yield Strength)

  - Weldability - Distortions, Ferritic Content, Fumes, Microsegregation

# Surface Ship Nonmagnetic Hull Materials

## New Materials Fabrication Considerations

- **Plate Sizes:**
  - ~ 8 Feet Wide
  - If Heat Treating, Less Than ~ 50 Ft Long
  - Plate Thicknesses Greater Than .375" ( Current SS up To 0.75 inches)
- **Joining Technologies:**
  - Preserve Base Plate Properties in the Joint
  - Low Cost (No Preheat, Cooling Rate Insensitive, Resistance to Hydrogen Cracking)
  - Low Distortion, Environmentally Compliant
  - Shipyard Usage Issues: T Stiffeners, Portability, Worker-friendly Etc.

# Future Application Opportunities

- **Nonmagnetic Double Hull Construction Concept For Navy Surface Combatant**
- **Nonmagnetic Submarine Hulls**
- **Protection Plating Systems (Magazines, Control Centers, Propulsion & Power Centers)**
- **Corrosion and Wear Resistant Coatings for Machinery Components**
- **Stiff, Lightweight Structural Panels (Foams, Lattices, etc.) to Reduce Weight, Particularly Topsides on Surface Combatants and Aircraft Carriers**
- **High Strength SCC Resistant Fasteners**

# “Coupon-To-Ship Capability”

Present Ship Development



**CARDEROCK  
TEST POND**



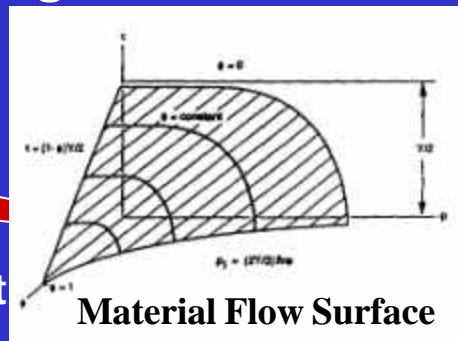
**UTF ABERDEEN TEST CENTER**



**AT - SEA  
SHOCK TRIALS**

**COUPON TESTING**

**Physics-Based Material and Structural  
Modeling & Simulation Capability**



**Material Flow Surface**

**Eliminate Costly  
Subscale Tests**

**Shorter Development  
Time / Lower Costs**

**Less Environmental Impact**

**More Efficient Designs**

# Summary

- **Ferrous Alloys with High Corrosion Resistance**
  - Estimated Cost of Corrosion to Navy is \$ 2 B annually
  - Numerous Bulk Material Replacements or Coatings
- **Ship & Submarine Hull Materials**
  - 100 % Increase in Yield Strength of Today's Hull Materials w/ 100 % Increase in Dynamic Fracture Toughness
  - 50 % Increase in Modulus of Elasticity
  - Nonferromagnetic Behavior
  - No Crevice Corrosion for Life of Ship
  - 100 % Increase in Stress Corrosion Resistance at Strength Level
  - 50 % Reduction in Cost of Today's Superaustenitic Stainless Steels